Shifting Landscapes: How Chinese SOE Foreign Investments Affect Recipient Country Market Concentration

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Abstract

This project analyzes the 514 foreign investments made by Chinese SOEs between January 2005 and December 2015 and considers their effects on market competitiveness as measured by country-and-industry-level HHI. The results describe how the investment volume and Chinese government stake in an SOE significantly affect HHI, but the other tested measures of Chinese state influence do not. These findings reflect the confirmed legal advantages and prevalent M&A behavior adopted by SOEs in virtue of them being vessels for CCP foreign policy. Prospective recipient countries may extrapolate conclusions to limit the type or size of Chinese SOE investments given this information. To further confirm the validity of these results, alternative indicators for market competitiveness and state control over SOEs ought to be explored. Additional exploration into this subject area could investigate the effects of Chinese SOE investments from other lenses, for instance, considering if the investments are justified based on their expected rates of return.

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Introduction

Despite numerous predictions that state-owned enterprises (SOEs) would not survive, Chinese SOEs continued to rise globally with a business strategy predicated on outward investments and reliance on Chinese Communist Party (CCP) resources. What originated as entities offering public services to Chinese citizens evolved into multinational mega-corporations dominating core industries, including energy and construction, globally. Theoretically, deals entered by these companies should be beneficial for both China and recipient countries; otherwise, there would be no reason for both parties to continue entering these transactions. Despite this ideal, international concern about ulterior geostrategic and economic motives has accompanied the rapid global emergence of Chinese SOEs in recent years. Scholars have argued that CCP influence has had overwhelming positive effects on efficiency within the state-owned companies and the Chinese economy overall, but it is unclear if these benefits extend beyond China.

Much literature has analyzed the investment patterns of Chinese SOEs and how they fueled China's modern economic growth. However, an underexplored aspect of these companies and their investments is how they affect markets of recipient countries. This dimension is particularly relevant for understanding the broader effects of China's ongoing foreign policy endeavors. As China embarks on the Belt and Road Initiative (BRI)—arguably its most ambitious and far-reaching investment project in history—with SOEs leading the charge, potential economic effects on industries in different countries ought to be examined in greater detail. This project analyzes the foreign investments of Chinese SOEs to understand the effect these transactions have on market competitiveness globally. A comprehensive examination of

these companies from a diversified set of industries assists in dissecting the incremental results of Chinese SOE behavior.

Background[1]

SOEs Explained

SOEs, also referred to as government-owned corporations (GOCs), are companies that are partially or fully owned or operated by a national, regional, or local government. They originated in Europe to create natural monopolies that promoted societal wellbeing (International Monetary Fund, 2020). The free market could not effectively provide services like utilities or healthcare, but there also was not sufficient public funding to guarantee them in the long-term, so a middle ground needed to be found. An SOE offered a solution for both issues. They could be started with the public funding that was available, but they would be operated with profitability as a core goal, like that of a private business. In struggling years, they could be assisted by the government, and in profitable years, they would increase government revenue and SOE shareholder wealth (Peng et al., 2016).

The emergence of these companies came with an emergence of critics. Leading the charge, János Kornai argued that these companies and "market socialism" more generally—where markets exist but state-owned firms comprise a large share of a state's economy—were untenable. To him, a society that sat halfway between socialism and capitalism would reap the benefits of neither system and eventually implode on itself (Kornai, 2007). Other scholars joined in his line of logic, arguing that the line between public and private should not be traversed. SOEs tended to be less efficiently run due to the nature of bureaucratic governmental systems

[1] For reference, a glossary of acronyms and initialisms defined and used throughout this paper can be found in Appendix 1. A glossary of terms can be found in Appendix 2.

and the presence of a cushion if the company underperformed (Milhaupt and Pargendler, 2017). However, because they were fundamentally for-profit, they needed to charge higher than expected prices to stay afloat. They could offer neither the profitability and operational excellence of a private company nor the expansiveness and affordability of a government service (Kornai, 2007).

This corporate structure remains prevalent today, with over 2,197 being reported in OECD countries alone as of 2012 (OECD.org, n.d.). Collectively, these companies are valued at over $2 trillion USD, have over 6 million employees, and contribute to around 10% of global GDP (OECD.org, n.d.; Bruton et al., 2015). With subsidies and legal exemptions, SOEs fly above market principles that ground purely private businesses. They are given exclusive financing rates, subsidies, resources, and tax advantages which help them outcompete other companies in the acquisition bidding process (Grimsditch, 2015; Heng 2014). Additionally, they have the financial backing of the state to support them through unprofitable years and protect them from the complications of bankruptcy (Grimsditch, 2015). Operationally, they are also easier to scale given the expansive networks and geographical locations that state agencies have access to and are familiar with (International Monetary Fund, 2020).

The History of Chinese SOEs

Chinese SOEs were formed in 1949 in conjunction with the People's Republic of China to provide essential services and rebuild the disaster-torn country (Gang and Hope, 2013). As predicted by Kornai, these companies faced a series of problems due to their corporate structure. They struggled with to produce steady income after accounting for a laundry list of expenses but continued to be propped up by state resources. The SOEs also harmed the private business

landscape within China. Private businesses did not have the advantage of government backing to support them in times of unprofitability. Until 1978, SOEs were the predominant corporate structure of Chinese companies (Grimsditch et al., 2015).

Beginning in 1978, the Deng Xiaoping regime introduced free market principles, requiring them to undergo a series of sweeping reforms (Lin et al., 2020; Heng, 2014). The common business ways of SOEs shifted during this period. The focus on profitability took a front seat as the companies embarked on lucrative opportunities abroad. SOEs undertook unprecedented amounts of debt, increasing average leverage ratios from a reasonable 18.7% to an alarming 79% between 1980 and 1994 (Wu, 1999). The support of the Chinese government initially allowed them to take greater risks to realize greater returns. Former SASAC Chairman, Li Rongrong analogized that state funding was the blood pumping through the "vital arteries" of the Chinese economy (Dobson, 2014). However, managers in these companies lacked accountability. They were granted autonomy with no supervisors to report to, allowing corruption and mismanagement to run rampant (Heng, 2014; Chen, 2013). Resultantly, over 238,000 of the SOEs, more than two-thirds of all in operation, recorded net losses in 1998 (Ralston et al., 2006).

In 2003, the State Assets Supervision and Advisory Committee (SASAC) of the State Council had been established to oversee the functions of the SOEs deemed central to China (The World Bank and Development Research Center of the People's Republic China State Council, 2012). The least profitable SOEs were either permanently closed, merged, or acquired by local municipalities or more profitable SOEs (Heng, 2014; Lin et al., 2020). These consolidations and restructurings significantly reduced the average amount of debt held by these companies and increased the percentage of profitability across them (Heng, 2014). The corporatization of these

entities also furthered their involvement in China's internationalization plan that began in 2000 (OECD.org, 2009).

Chinese SOEs became unique in their reliance on foreign business. In 2020, over 60% of Chinese SOE revenue was obtained overseas, as opposed to 0% in 1949 (Wang, 2021). In 2013 alone, the combined value of all Chinese overseas investments surpassed $107.84 billion USD (Ministry of Commerce, National Bureau of Statistics and State Administration of Foreign Exchange, 2014). In all other countries, the vast majority of outward investments are made by completely private companies (Huang and Wang, 2011). Meanwhile, beginning in 2009, SOE investments comprised over 70% of all outward investments from China (Huang and Wang, 2011). Mergers and acquisitions (M&A) were a common deployment of these investments. China arose as a "national strategic buyer", completing over $96 billion in M&A transactions in 2016 alone (Gordon and Milhaupt, 2018).

Between their inception and the current day, the goal of many SOEs transformed from providing accessible, essential services for the Chinese public to maximizing profit and furthering state interests internationally. This strategy is responsible for Chinese SOEs' rise to prominence. Of the 204 largest SOEs listed in the 2012 Forbes Global 2000 list, 70 were Chinese, with India at 30 being the next largest player (Kowalski et al., 2013). All four Chinese state-owned banks ranked within the ten largest public companies in the 2020 Forbes Global 2000 list, and for the eighth consecutive year, the Industrial and Commercial Bank of China (ICBC) ranked first (Murphy et al., 2020).

Modern CCP Influence Over Chinese SOEs

Embedded in the functioning of SOEs is allegiance to the CCP. The reform of SOEs was partially driven by domestic economic motives like achieving operational excellence, but, in part, it was also motivated by the desire to align companies with CCP goals. SOE reform remains a continuous process of blurring lines between the CCP and Chinese businesses. In 2015, the CCP General Committee and the State Council released a guidance for SOEs which explains that:

> "…adhering to the [CCP]'s leadership over SOEs is the political direction and principle when deepening the reform of SOEs. It is necessary to implement the principle about overall strict governance of the Party, to [fully] play to the political core role of the Party organization in companies, to strengthen the construction of the leading group in companies, to innovate the work of [Party] building at the primary level, to deepen the construction of a clean and honest Party, to wholeheartedly rely on the working class, to safeguard the legitimate rights and interests of employees, and to provide a strong political and organizational guarantee and human resource support for the reform and development in SOEs."[2]

The covered topics were focused on domestic issues such as fostering patriotism and support for employees. These tactics emphasize employee identification with the CCP, strengthening its influence from within companies themselves. Wording like "to wholeheartedly rely on the working class" puts the onus on employees to fulfill CCP goals like "implement[ing]

[2] This translation was copied from Lu and Zhu (2020). Brackets were added for clarity and consistency.

the principle about overall strict governance of the Party". However, the guidance deployed wording like "innovate the work of [Party] building" that can be construed ambiguously to maintain the guise of autonomy within SOEs (Lu and Zhu, 2020). It does not explicitly give direct instructions for how these goals will be achieved or allude to the nature of SOE expansion over the previous decades.

In the following years, SOEs were more openly utilized to further geostrategic moves for the CCP, following themes of how the CCP deploys authoritarian control over most crucial aspects of China. However, these efforts have never been as brazen. A 2017 guidance read:

> "…it is the unique advantage of SOEs to insist on the [CCP]'s leadership and to strengthen the Party building. It is necessary to clarify the legal status of the Party organization in the corporate governance structure of SOEs, to incorporate the general requirements of the Party building in the regulations of SOEs, and to clarify the rights, responsibilities and working methods of the Party organization in the decision-making, implementation and supervision processes, so as to make the Party organization an integral part of the corporate governance structure. In addition, it is essential to [give] full play to the [leading political role] of the Party, to lead the ideological and political work of the companies, to support board of directors, board of supervisors and management to perform their duties in accordance with the law, and to ensure the implementation of the [Party's] national policies" [3]

It continues:

[3] This translation was copied from Lu and Zhu (2020). Brackets were added for clarity and consistency.

> "…the Party members among directors, supervisors, and management team of SOEs shall regularly report to the Party group (Party committee) about the performance of their duties, integrity and self-discipline every year… [and] actively explore the ways and methods of the organic combination between the principle of the Party's managing cadres and board's selection and appointment of management personnel. By insist on and improving the leadership system of two-way entry and cross appointment, qualified members of the Party group (Party committee) in SOEs can be a member of the board of directors, board of supervisors and management through legal procedures. Qualified members of board of directors, board of supervisors and management are able to enter the Party group (Party committee) according to relevant regulations and procedures; the position of secretary of the Party group (Party committee) and chairman of board of directors should be taken by the same person generally and promote the project about appointing the Deputy Secretary of the Party group (Party committee) as a member of board of directors in centrally-administered SOEs." [4]

The first passage describes the general structures the CCP expects SOEs to implement while the second passage clarifies specific directives for their goals. These passages establish a strong allegiance to the party that is reinforced with both supervision and weight on "self-discipline." In addition to securing profit, SOEs must allow "full play to the [leading political role] of the party," "ensure the implementation of the [Party's] national policies," and create a CCP committee that is "an integral part of [its] corporate governance structure." From the laws and

[4] This translation was copied from Lu and Zhu (2020). Ellipses and brackets were added for efficiency.

regulations to the boards of companies themselves, the CCP has been gradually expanding its circle of influence over SOEs and the goals of SOEs themselves. In exchange for compliance with these guidances, the CCP offers even more preferential treatment for the most loyal companies. SOEs are already given advantages from the Chinese government, for instance, a functionally unlimited line of credit and exclusive access to governmental resources (Dorn, 2015). These guidelines further increase the gap between private businesses and SOEs, allowing them to deploy their capital even more effectively in comparison.

Recently, in the face of international critics, President Xi Jinping has also shamelessly embraced SOEs under the condition that they would continue to allow the expansion of CCP control over them (Buckley and Bradsher, 2020). He approved a three-year plan, effective July 2020, that would even further augment the role SOEs play in the global economy (Tang, 2020). The action plan, with endorsement from the Central Comprehensively Deepening Reforms Commission, argued that the coronavirus underscored the reliability of SOEs and sustainability of a "socialist market economy" (Tang, 2020). Despite numerous analyst predictions that the plan will be ineffectual, Xi continues to defend it. The report from the commission states:

> "State-owned enterprises are an important material and political foundation for socialism with Chinese characteristics. They are the key pillar and force for the party's rule and the country's revitalization… We will improve their economic competitiveness, innovation capabilities, their ability to control the economy, their influence as well as their capability for control of and resistance to risks."

Mixed Conclusions Around International Treatment of Chinese SOEs

Within China, the perceived business effects of these types of guidances are largely positive, especially from a corporate governance perspective. One study found that the impression of CCP surveillance reduced excess compensation of executives and resulted in greater efficiency in managing salary expenses (Ma et al., 2013). However, the effects on China's neighbors and recipient countries are less clear. The blatant promotion of CCP goals by these companies in the vast majority of cases does not align with the wants of other countries. Many states have attempted to limit the activities and influence of wholly private companies due to perceived state ties,[5] so they are even more wary of SOEs for this reason.

For instance, the United States-China Economic and Security Review Commission published a report recommending Congress to "amend the statute authorizing the Committee on Foreign Investment in the United States to bar Chinese state-owned enterprises from acquiring or otherwise gaining effective control of U.S. companies." The recommendation was justified by the suspicion that such transactions would allow the SOEs to use "technology, intelligence, and market power…in the service of the Chinese state to the detriment of U.S. national security" (United States-China Economic and Security Review Commission, 2016). If adopted, this proposal would shift the way the Committee on Foreign Investment in the United States (CFIUS)[6] reviews Chinese SOE transactions. CFIUS approved the $43 billion acquisition of Syngenta by ChemChina, giving the 100% state-owned company control over major portions of the agrichemical supply chain (Copeland, 2016). Historically, CFIUS has also been particularly lax with minority-stake SOEs, even if they were acquiring a controlling stake in an American

[5] For instance, the Trump administration released announcements of a ban against TikTok earlier in 2020 (Buckley and Bradsher, 2020).
[6] CFIUS

company (Copeland, 2016). Another instance of hesitancy to deal with CCP-affiliated organizations occurred in April 2021. Australia cancelled a multi-billion-dollar infrastructure agreement with China's National Development and Reform Commission (Westcott, 2021; Premier of Victoria, 2019). Australia's foreign affairs minister, Marise Payne, then called the deal "inconsistent with Australia's foreign policy or adverse to [their] foreign relations" (Westcott, 2021).

Not all scholars follow this line of reasoning though. Dr. Wendy Dobson, a Professor Emerita of Economic Analysis and Policy at the University of Toronto argues that concerns about CCP political and economic influence are "overblown." She argues that, unexpectedly, Chinese SOEs are more transparent than some from other countries, including Canada, so if any, more scrutiny should be directed to those countries. By rejecting Chinese SOE investments, Canada misses out on opportunities to grow its economy and drive innovation in its energy sector especially. Chinese SOEs face no shortage of investment opportunities, so by barring them from certain transactions, Canada would be allowing other countries to surpass it. Dobson also explains that even if worries of CCP influence are true, they should be weighed against the net benefits of the investments and other possible remedies.

For instance, the activities of the China Ocean Shipping Company (COSCO) serve as a case study with favorable results of Chinese SOE involvement in the United States. After Maersk Line, a Danish shipping company ended their relationship with the Massachusetts Port Authority, COSCO invested in the Port of Boston (Yan, 2012). David Mackey, then-CEO of the Massachusetts estimated that this investment saved over 34,000 jobs through the ten-year relationship and recognized COSCO for its contribution to the American economy (Yan, 2012).

Benefits like these should be weighed against potential consequences before uniformly restricting Chinese SOEs from certain transactions (Dobson, 2014).

Defining Project Scope

For the purposes of this project, the Chinese government will have an ownership stake in all the SOEs considered. Roughly, SOEs can be divided into for-profit entities and those that provide public services (Guluzade, 2019; Gang and Hope 2013). Only for-profit SOEs with international operations and investments from 2005 to 2015—a period that is representative of modern Chinese SOEs and their projected growth patterns over the next decade —will be considered (Lin et al., 2020). Many Chinese SOEs limit themselves to domestic operations and pose interesting questions about the mixing of business and government, however, these entities are external to the topic of this project.

The focus of this project lies within the broader context of considering the overall impact of Chinese SOE foreign investment activity. The effects of these actions by Chinese SOEs have been analyzed from geopolitical, humanitarian, economic perspectives, and more. This project will specifically consider a crucial dimension of economic effects on recipient countries: competitiveness. Competitiveness encapsulates many of the concerns from international critics described previously, including unfair advantages for SOEs and restrained access to resources following transactions.

Competitiveness in this paper will refer to market competitiveness in the context of general equilibrium theory.[7] In a perfectly competitive market, all buyers and sellers face the

[7] To avoid confusion, the term "economic competitiveness", although facially equivalent, will not be used in this paper. The phrase is widely used as a term of art describing how successful a country or region of the world is at competing in the global economy (see Metropolitan Council (n.d.). Economic Competitiveness. https://metrocouncil.org/Handbook/Plan-Elements/Economic-

same price determined by supply and demand. There exists a seller for every buyer interested in a good or service. Sellers cannot charger higher prices because buyers have a plethora of other sellers offering virtually indistinguishable items to choose from. No rational buyer would pay more for a good when an equal one is available for less. At the same time, sellers cannot charger lower prices because that would entail incurring major losses and having to leave the market. There is free entry and exit from the market which allows for price adjustments in the long run. These theoretical markets are characterized by the availability of choices for interested buyers and the lack of price-setting power for sellers. In sum, this equilibrium state "coordinates productive effort, balances supply and demand, and leads to an efficient allocation of goods and services in the economy" (Levin, 2006).

The structure of actual markets strays from this ideal in meaningful ways. On the most extreme end, a monopoly is the opposite of a perfectly competitive market; there is one producer who controls the supply and price of a particular product. A well-known real-world example of a monopoly was the De Beers corporation until the early 2000's. The company owned an expansive network of global mines and artificially induced diamond scarcity to increase buyers' willingness to pay for the gems. Following regulatory pressures, the company released its monopoly status and has not been able to rebound profits since (Biesheuvel, 2020). Less competitive markets facilitate augmented profits for sellers at the expense of buyers. This example concerns a non-essential luxury good, but markets for necessities can also stray in this

Competitiveness.aspx#:~:text=Economic%20competitiveness%20i%20n%20the%20context%20of%20comprehensive,that%20bring%20wealth%20into%20a%20community%20or%20region.). The economic competitiveness of the United States, for example, would be determined by how efficiently it innovates and produces products that are preferred above similar ones made elsewhere. Meanwhile, market competitiveness in this paper is concerned with industry level analyses and seller market power dynamics.

direction. As markets become less competitive, they move towards these unjust situations where corporations wield power over buyers.

Hypotheses

Hypothesis 1

Hypothesis 1: The change in an industry's competitiveness is positively correlated with the volume of total investments from Chinese SOEs. Let a low "competitiveness" statistic represent a perfectly competitive market and a high one represent a more fragmented, concentrated one. Figure 1 depicts the model being tested with this hypothesis.

Figure 1: Hypothesis 1 Model[8]

$$\Delta Competitiveness = Total\ Investments + C$$

Investment volume has the potential to drastically shape the competitive landscapes of recipient industries in a few ways. First, investments can be directed toward M&A transactions. When companies in the same industry combine, they automatically control a larger portion of their market. The consumers for the pre-M&A companies are now consumers of one amalgamated company, and the new company's share of the market is greater than each of the pre-M&A companies' shares individually. These transactions can thus result in less competitive markets because the large company has fewer competitors and can have more power in setting prices, especially if it provides an essential good or service.

Second, investments can fuel the growth of companies that, willfully or not, create anticompetitive environments as a byproduct of their success. For instance, a once common strategy used by newly formed companies was to undercut competitors and sustain losses until

[8] Let C equal some constant.

the new company becomes the dominant player in a market. The incumbent companies may not be able to withstand this heightened price competition, allowing the new company to gain market share. Although this practice called predatory pricing is regulated against in most developed countries, it arguably is still pursued in various sectors including retail and entertainment (Bolton et al., 2000; Lecher, 2019). Given the propensity for SOEs to engage in M&A activity and their ability to weather significant losses, both explanations for competitive landscape shifts may be at play.

Hypothesis 2

Hypothesis 2: The change in an industry's competitiveness is positively correlated with each Chinese state control variable of SOEs that invested in it. Figure X depicts the model being tested with this hypothesis.

Figure 2: Hypothesis 2 Model

$$\Delta Competitiveness = \sum State\ Control\ Factors + C$$

The ownership structure of an SOE can affect how decisions are made within the firm. In traditional corporations with "control-minority" situations,[9] agency problems may arise due to misalignment between controlling and minority shareholders (Bebchuk et al., 2000). In SOEs, the difference in priorities between the state and private, individual stakeholders is even greater (Milhaupt and Pargendler, 2017). Without a majority economic interest in a company, the state has fewer incentives to pursue financial goals but equivalent power to pursue political ones

[9] Control-minority situations occur when minority economic shareholders possess the majority of voting equity in a company. This status is also sometimes referred to as "working control."

(Milhaupt and Pargendler, 2017). Most countries have attempted to avoid this issue by requiring equal share ownership to voting rights or by proactively restricting the government's voting rights (Milhaupt and Pargendler, 2017). A higher government percentage ownership stake in a Chinese SOE results in higher economic stakes with their investment decisions and thus could result in a greater incentive to promote financial interests which are magnified when the remainder of an industry is not competitive.

Although SOEs face some tension between political and financial motives, political motives in many cases are largely driven by financial ones. Dr. Ritika Passi of the Observer Research Foundations analyzed BRI plans and argued that the distinction between economic and non-economic motives for SOEs foreign investments can become tenuous. The two cannot be disentangled in many cases. She uses infrastructure, the "OBOR's foundational and most visible element as an example (Passi, 2019). Although China arguably has an interest in political domination through control of trade routes along the original Silk Road path, these aims are fundamentally rooted in its desire for economic growth (Passi, 2019). In cases like these, it is reasonable to predict that the state control factors will concurrently result in stronger economic effects; the greater the influence of the state, the lower the influence of outside individuals and the higher the drive for both profit and power in international politics.

The composition and role of boards at SOEs can also influence how investment activity occurs in the firm. A strong principle in international SOE governance is maintaining an independent board of directors from the government (Milhaupt and Pargendler, 2017). The reasoning behind this principle is separating financial motives from political ones. As a result, some countries have instituted measures that prevent politicians and regulators from serving on boards or limiting the power of board members should government officials be allowed on them.

For instance, Norway bans all civil servants and Brazil bans regulators, politicians, and union leaders from serving on the boards of SOEs (Milhaupt and Pargendler, 2017). Chinese SOEs had similar regulations prior to the passage of the 2015 guidance, which may have allowed financial interests to take precedence in matters of foreign investment (Lu and Zhu, 2020).

Hypothesis 3

Hypothesis 3: An industry's competitiveness score is positively correlated with the volume of total investments when scaled by the level of Chinese state ownership in an enterprise. Figure X depicts the model being tested with this hypothesis.

Figure 3: Hypothesis 3 Model

$$\Delta Competitiveness = Total\ Investments + \sum State\ Control\ Factors + C$$

Even if individually, investment volume or Chinese governmental control do not have a positive correlation to the concentration of markets, it is possible that the factors considered in conjunction do. High investment volumes may not be sufficient to cause a ripple in market competitiveness if the CCP has a minimal economic interest in an investing company. In this case, the conjunction of investment volume and CCP influence explains the falseness of Hypothesis 1. Conversely, high levels of CCP influence in a company may not affect market concentration until investments pass a size threshold. Similar to the previous example, a correlation may only arise when the two factors are considered together. The conjunction of different investment behavior and different CCP interests may be able to explain variation more comprehensively than each factor in isolation.

Methods

Competitiveness

The Herfindahl-Hirschman Index (HHI) measures how concentrated an industry is and will be used as a proxy for market competitiveness. Market concentration describes how spread-out market share is among all the firms in an industry. Low market concentration indicates that the percentage of revenue generated by each firm is low and approximately equal to the share of all other firms. Factors that shift market concentration and market competitiveness include corporate consolidation, the regulatory environment, and the ease at which a company can enter a market.

The HHI is the most widely accepted indicator for competitiveness and has been proven to be theoretically robust (Rhodes, 1993; Herfindahl, 1950). Countries deploy the HHI differently in their considerations, but it is generally considered a standard variable for antitrust cases around the world (Rhodes, 1993). For instance, the United States considers M&A activity that raises the HHI by two basis points, or 20 points on a scale of 10,000, "likely to enhance market power" and thus worthy of thorough investigation prior to approval (The United States Department of Justice, 2018). Alternatively, the European Commission merger assessment guidelines mainly considers the end size of industries, reading:

> "The Commission is unlikely to identify horizontal competition concerns in a market with a post-merger HHI below 1000. Such markets normally do not require extensive analysis. 20. The Commission is also unlikely to identify horizontal competition concerns in a merger with a post-merger HHI between 1000 and 2000 and a delta below 250, or a merger with a post-merger HHI above 2000 and a delta below 150, except where special

> circumstances such as, for instance, one or more of the following factors are present: (a) a merger involves a potential entrant or a recent entrant with a small market share; (b) one or more merging parties are important innovators in ways not reflected in market shares; (c) there are significant cross-shareholdings among the market [participants]; (d) one of the merging firms is a maverick firm with a high likelihood of disrupting coordinated conduct; (e) indications of past or ongoing coordination, or facilitating practices, are present; (f) one of the merging parties has a pre-merger market share of 50% [or more]."

The HHI sums the squared value of the market share of all firms within an industry with a lower score representing a more competitive market (Herfindahl, 1950). Squaring is effective because it accurately represents the effect of having firms with little market share without altering the effect of a large firms. The figure below describes the formula for calculating HHI.

Figure 4: HHI Formula[10]

$$HHI = \sum_{i=1}^{n} {s_i}^2$$

$$s_i = \frac{\rho(x_i)}{\sum_{i=1}^{n} \rho(x_i)}$$

Market share will always range between zero and one, inclusive of one but not zero. In a monopoly, the single firm's revenue is equivalent to the sum of all firms' revenue, so the market share equals one. In a perfectly competitive market, market share approaches, but does not equal,

[10] Let s represent the market share of x where x is assumed to be a firm. Let the notation ρ(x) represent the gross revenue of x. The denominator of the formula for s is also referred to as the market size of a given industry. Across market share calculations within the same industry, the market size does not change.

zero. Each firm has a negligibly small share of the market that will continue to decrease as more firms enter the market. However, the numerator, revenue, definitionally cannot equal zero; otherwise, the firm would not be in the industry at all. Because market share never exceeds one and neither does the sum of all market shares, HHI will also never exceed one. Intuitively, this calculation also reflects shifts in market landscapes. For instance, M&A activity results in one company's original share vanishing and another one's being augmented, which will result in a higher HHI due to the new formula inputs. To show the magnitude of changes more effectively, HHI will frequently be scaled by 10,000.[11] This scaling will also be adopted for analyses in this paper.

Investment Volume

Investment volume will be evaluated on a yearly industry-and-country-level basis with USD as its unit. Investment amounts will only include completed deals and be counted in the year that the capital was deployed. Because the evaluation period 2005 through 2015 is relatively short, investment values will not be adjusted to account for the time value of money. They will be presented as the value of the capital at the time of investment. If a transaction had multiple investors, it will be assumed that the investors contributed an equal percentage unless otherwise indicated in reporting on the deal. Oftentimes when SOEs invest alongside each other or pursue joint ventures, they share the burden of capital investment (Grimsditch, 2015). They also tend to use same funding sources, so assuming the money was distributed evenly is roughly in accordance with this fact (Lin et al., 2020).

[11] Much literature also begins with the premise of HHI ranging from 0 to 10,000 where the share of a firm comprising 20% of an industry would be computed as 20 rather than .2.

State Control Factors

State control factors will reflect the degree to which the CCP has influence over a company. The first factor is the Chinese government's percentage ownership stake in an SOE. Ownership stake affects an SOEs capital structure and the availability of state resources for it (Huang et al., 2018; Gang and Hope, 2013). It also directly reflects the level of financial interest the government has in an SOE. This metric is a reliable gauge for state control but other factors could be relevant as well.

Even if the government does not own a large stake in an SOE, it can still heavily influence the company's projects and business dealings (Bruton et al., 2015). The second factor, supervision over the SASAC, reflects these cases. The main SOEs are operated by the SASAC, but the Chinese government does not necessarily hold large stakes in them (Gang and Hope, 2013; State-owned Assets Supervision and Administration Commission of the State Council, n.d.; Scissors, 2020). The SASAC ensures that SOE actions are in alignment with CCP goals, and it can play a role in strategizing expansive projects and facilitating engagement with private firms (Shen and Galbraith, 2020). The SASAC also provides SOEs additional dividends through heightened investments and support through restructuring, allowing them to mirror the strategies of global investment banks (Dobson, 2014).

Lastly, the third factor will be involvement with the BRI. The Xi administration characterizes the BRI as "new round of opening to the world" and indicates that they plan to heavily direct companies through this globalization effort to best ensure their desired results (Cheng et al, 2019). Some companies possess resources, leadership, and networks that are valuable for the BRI but otherwise are not of specific interest to the CCP (Cheng et al., 2019). Even if a company has a low government ownership stake and is not under SASAC supervision,

entrance into a BRI contract entails that for the duration of the project, the company is responsible for promoting Beijing's aims. This variable—whether an investment is associated with the BRI—and the presence of SASAC supervision will be treated as indicator variables while ownership stake will be treated as numerical or categorical, between majority or minority, depending on the model. Additionally, this variable will be evaluated on a transaction-level basis while the others are at the company-level.

Additional Variables

There is conflicting evidence about how greenfield and brownfield investments affect economic growth and market composition. An article published in the Review of International Economics studied 127 countries over the period 1990 to 2010 and found that greenfield investments enhance economic growth while brownfield investments, at best, have no effect on it (Harms and Méon, 2017). Conversely, an article from Usak University researchers found that both greenfield and brownfield investments enhance economic growth, but greenfield investments had a significantly stronger effect (Bayar, 2017). Another study concludes that greenfield investments cause a type of "crowding out" effect that deters domestic private investment while brownfield investments do not (Ashraf and Herzer, 2014). Regardless, there is consensus that greenfield and brownfield investments affect recipient countries in meaningfully different ways, so that factor could potentially be relevant in this project and is thus accounted for in certain models below. Like the last two variables above, whether an investment is greenfield or brownfield will be treated as an indicator variable.

Data Compilation

Investment data was sourced from the American Enterprise Institute's (AEI) China Global Investment Tracker (Scissors, 2020). This dataset includes the individual investments made by companies over the period January 2005 through June 2020. Only objective information like the company name, government ownership stake, investment volume, and industry of operation are included. Derek Scissors, the think tank's Chief Asia Economist, records the completed deals on an approximately quarterly basis. Investments after December 2015 were not included for analysis, because there lacks sufficient data about more recent changes in HHI globally.

Industry boundaries were determined by four-digit codes from the 2017 North American Industry Classification System (NAICS), the most recently published manual (Office of Management and Budget, 2017). For less disaggregation, three-digit and two-digit NAICS codes were also used. NAICS codes divide industries using their production processes and are updated every five years to reflect technological advancements and sector-wide shifts (Office of Management and Budget, 2017). The manual demarcates 20 industries with two-digit codes and then subclassifications within it using three, four, five, and six-digit codes signaling increased specificity (Office of Management and Budget, 2017).

For each investing company, two measures of state control were recorded: the government's ownership stake in the company and supervision from the SASAC. Government ownership stake was listed in the China Global Investment Tracker. Recorded companies were crosschecked against the SASAC's published list of central SOEs to determine the second state control factor (State-owned Assets Supervision and Administration Commission of the State Council, n.d.). The transaction-level measure, contract involvement with the BRI, was also

pulled from the China Global Investment Tracker and updated, if needed, using reports from various media outlets.

HHI by country was sourced from The World Bank's TCdata360 initiative HHI Market Concentration Index database (The World Bank, 2015). HHI by country was also sourced from The World Bank's World Integrated Trade Solution (WITS) HHI Market Concentration Index database. HHI by industry was sourced from the US Census Bureau. Every spreadsheet in which data was pulled from was compiled into the attached sheet called "intsheets.xlsx". Then, relevant data was cleaned and extracted into the attached final dataset used for analysis, "thesisdata.csv". More detailed explanation of the source data and its analysis can be found in Appendices 3 and 4.[12]

Results

Hypothesis 1

As depicted in Figure 5, there was a significant relationship between the total investment volume and the change in HHI. However, the effect size was minimal, and the R^2 value was very small for this model. With the ordinary least squares (OLS) regression, it was estimated that for every $1 million increase in investments, HHI on the 0 to 10,000 scale increases by .021. This increase would represent only .12% of the average one-year HHI change observed and .11% and .09% of the two and three-year changes, respectively (Figure 1). Considering the relationships under a logistic model revealed an odds ratio (OR) of .0001 (Figure 1). On average, every $1 million increase in total investment volume increases the probability of a positive HHI change by

[12] Appendix 3 contains a complete guide of the types of source data that were compiled to product the final dataset for analysis. In the final sheet, formulas for calculating cell values were removed in the interest of reducing storage space, so Appendix 4 also contains a detailed replication guide covering the exact steps needed to reproduce the attached csv files and results described in this paper.

.0001. The low R^2 and adjusted R^2 indicate that describing the total investments alone does not account for much variation in the data, and more variables are needed to fully describe the cause for HHI changes.

Figure 5: Hypothesis 1 Model Results[13]

	Dependent variable:	
	HHI Increase Amount	Likelihood of HHI Increase
	OLS	*logistic*
	(1)	(2)
Total Investments	0.021**	0.0001
	(0.009)	(0.0001)
Constant	-1.640	0.257**
	(15.464)	(0.112)
Observations	480	484
R^2	0.011	
Adjusted R^2	0.009	
Log Likelihood		-329.477
Akaike Inf. Crit.		662.954
Residual Std. Error	280.356 (df = 478)	
F Statistic	5.259** (df = 1; 478)	
Note:		*p<0.1; **p<0.05; ***p<0.01

These conclusions are supported by the difference in means for one-year, two-year, and three-year HHI changes. Total investments tend to be higher in cases when HHI increased but not by much. In the two-year time frame, the average difference in total investments between

[13] Tables were formatted using the R package "stargazer" (see Hlavac, M. (2018). stargazer: Well-Formatted Regression and Summary Statistics Tables. R package version 5.2.2. https://CRAN.R-project.org/package=stargazer.).

cases where HHI increased and cases where HHI decreased was less than $3 million, a small fraction of the total outward investment in any given year (Figure 6).

Figure 6: Yearly Average Total Investments by Time Period and HHI Change

	Average Total Investments
1 Year HHI Increase	1005.3760
1 Year HHI Decrease	901.2195
2 Year HHI Increase	956.9636
2 Year HHI Decrease	954.7210
3 Year HHI Increase	986.8898
3 Year HHI Decrease	917.4091

Given overall average total investments of 954.6012 and a standard deviation of 1393.2550, a Z-test for the difference in means revealed that the differences are not significant under typical norms for p-values.[14] Although a difference is depicted in Figure 6, it cannot be solely attributable to different investment volumes.

[14] The number of observations was 514. One-sided tests were assumed. The results of the Z-Test were calculated as follows:

1. 1 Year HHI Increase (279 observations, standard deviation of 1566.829): $\frac{1005.3760 - 954.6012}{\sqrt{\frac{1393.255^2}{514} + \frac{1566.829^2}{279}}} = .45.$ 1- Z(.45) = .3264.
2. 1 Year HHI Decrease (235 observations, standard deviation of 1157.853): $\frac{901.2195 - 954.6012}{\sqrt{\frac{1393.255^2}{514} + \frac{1157.853^2}{235}}} = -.54.$ Z(-.54) = .2946.
3. 2 Year HHI Increase (247 observations, standard deviation of 1561.480): $\frac{956.9636 - 954.6012}{\sqrt{\frac{1393.255^2}{514} + \frac{1561.480^2}{247}}} = .02.$ 1- Z(.02) = .4920.
4. 2 Year HHI Decrease (267 observations, standard deviation of 1223.135): $\frac{954.7210 - 954.6012}{\sqrt{\frac{1393.255^2}{514} + \frac{1223.135^2}{267}}} = .001.$ Z(.001) = .5000.

Hypothesis 2

The average ownership stake in a Chinese SOE proved to be a significant predictor of HHI changes, but none of the other variables describing state influence were not. Adding the SASAC and BRI variables did not improve the R^2 values from Model 1 in Figure 7 on the next page, meaning the additional state control factors did not assist in explaining the variation in the data. SASAC supervision had a negative coefficient, which would have indicated that the investments of SOEs under SASAC supervision had a beneficial effect on market concentration. This finding would have been completely contrary to the predictions in Hypothesis 2, but the variable was not significant.

5. 3 Year HHI Increase (254 observations, standard deviation of 1582.493): $\frac{986.8898 - 954.6012}{\sqrt{\frac{1393.255^2}{514} + \frac{1582.493^2}{254}}} = .28$. 1-Z(.28) = .3897.
6. 3 Year HHI Decrease (260 observations, standard deviation of 1184.926): $\frac{917.4091 - 954.6012}{\sqrt{\frac{1393.255^2}{514} + \frac{1184.926^2}{260}}} = -.39$ Z(-.39) = .3483.

Figure 7: Hypothesis 2 Model Results

	Dependent variable:			
	HHI Change			
	(1)	(2)	(3)	(4)
Average Stake	63.015*	61.812*	63.326*	62.118*
	(32.964)	(33.478)	(33.039)	(33.551)
SASAC Supervision		-5.362		-5.397
		(25.187)		(25.213)
BRI Contract			5.882	5.930
			(31.031)	(31.064)
Constant	-15.880	-13.521	-17.017	-14.653
	(23.522)	(26.021)	(24.298)	(26.714)
Observations	474	474	474	474
R^2	0.008	0.008	0.008	0.008
Adjusted R^2	0.006	0.004	0.004	0.002
Residual Std. Error	247.331 (df = 472)	247.581 (df = 471)	247.584 (df = 471)	247.835 (df = 470)
F Statistic	3.654* (df = 1; 472)	1.846 (df = 2; 471)	1.841 (df = 2; 471)	1.240 (df = 3; 470)
Note:				*p<0.1; **p<0.05; ***p<0.01

It was then explored if separating the average stake variable into minority and majority would yield important results. Reconsidering the average Chinese government stake as a categorical variable—minority if it was less than or equal to 50% and majority if it was greater than 50%—revealed noticeable differences (Figure 8, Figure 9, Figure 10). The majority stake transactions, on average, resulted in larger changes in HHI than the remainder of the population, and the minority stake transactions, on average, resulted in smaller HHI changes.

Figure 8: Overall Change in HHI

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
1 Year HHI Change	484	17.085	253.099	-1,320.378	-16.891	34.296	3,515.398
2 Year HHI Change	480	18.270	281.600	-1,069.959	-29.995	49.197	3,998.256
3 Year HHI Change	474	23.493	248.024	-1,183.220	-33.674	71.740	2,013.027

Figure 9: Change in HHI for Majority Stake Transactions

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
1 Year HHI Change	290	26.534	306.414	-1,320.378	-20.496	34.772	3,515.398
2 Year HHI Change	287	27.447	330.892	-1,069.959	-29.995	66.133	3,998.256
3 Year HHI Change	281	38.809	271.035	-1,183.220	-31.094	83.211	2,013.027

Figure 10: Change in HHI for Minority Stake Transactions

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
1 Year HHI Change	194	2.960	139.241	-784.385	-16.156	33.786	1,038.859
2 Year HHI Change	193	4.623	185.544	-1,065.712	-29.481	32.784	1,118.444
3 Year HHI Change	193	1.194	208.745	-1,175.840	-43.739	39.381	477.038

Using a Z-Test to examine if the difference in means between these three samples is significant, it was found that the significance levels ranged between .1170 and .3483.[15] There was a larger

[15] One-sided tests were assumed. The results of the Z-Test were calculated as follows:

1. Majority stake transactions with a one-year timeframe: $\frac{26.534 - 17.085}{\sqrt{\frac{253.099^2}{484} + \frac{306.414^2}{290}}}$ = .44. 1- Z(.44) = .3300.
2. Majority stake transactions with a two-year timeframe: $\frac{27.447 - 18.270}{\sqrt{\frac{281.600^2}{480} + \frac{330.892^2}{287}}}$ = .39. 1- Z(.39) = .3483.
3. Majority stake transactions with a three-year timeframe: $\frac{38.809 - 23.493}{\sqrt{\frac{248.024^2}{474} + \frac{271.035^2}{281}}}$ = .77. 1- Z(.77) = .2206.

normalized difference between the minority stake sample and the overall sample, as compared to with the majority stake sample. The p-values from these statistics are not small enough to definitively conclude that the majority or minority stake transactions are significantly different from the holistic average.

Hypothesis 3

The models tested for Hypothesis 3 follow the Hypothesis 2 findings that state control factors besides average stake are not significant predictors of HHI changes (Figure 11). In each model with the additional features added, they were not significant and did not improve both the R^2 and adjusted R^2 values. Although R^2 and adjusted R^2 values were higher than in the previous models, they were still very small, so another model factoring in the starting HHI was tested.

4. Minority stake transactions with a one-year timeframe: $\frac{2.960 - 17.085}{\sqrt{\frac{253.099^2}{484} + \frac{139.241^2}{194}}}$ = -.93. Z(-.67) = .1762.
5. Minority stake transactions with a two-year timeframe: $\frac{4.623 - 18.270}{\sqrt{\frac{281.600^2}{480} + \frac{185.544^2}{193}}}$ = -.73. Z(-.73) = .2327.
6. Minority stake transactions with a three-year timeframe: $\frac{1.194 - 23.493}{\sqrt{\frac{248.024^2}{474} + \frac{208.745^2}{193}}}$ = -1.19. Z(-1.19) = .1170.

Figure 11: Hypothesis 3 Model Results

	Dependent variable:						
	HHI Change						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Total Investments	0.016**	0.018**	0.016**	0.018**	0.016*	0.017**	0.017**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Average Stake	68.905**	64.890*	69.212**	65.199*	78.058**	73.930**	74.892**
	(32.995)	(33.385)	(33.070)	(33.457)	(34.275)	(34.724)	(34.881)
SASAC Supervision		-20.990		-21.026		-19.758	-19.761
		(26.143)		(26.170)		(26.178)	(26.203)
BRI Contract			5.816	5.995			10.228
			(30.935)	(30.947)			(31.247)
Greenfield Investment					-24.942	-23.994	-25.148
					(25.275)	(25.318)	(25.586)
Constant	-34.844	-27.854	-35.967	-28.999	-32.171	-25.693	-27.543
	(25.318)	(26.783)	(26.038)	(27.454)	(25.464)	(26.882)	(27.495)
Observations	474	474	474	474	474	474	474
R^2	0.016	0.017	0.016	0.017	0.018	0.019	0.019
Adjusted R^2	0.012	0.011	0.010	0.009	0.012	0.011	0.009
Residual Std. Error	246.563 (df = 471)	246.656 (df = 470)	246.816 (df = 470)	246.909 (df = 469)	246.570 (df = 470)	246.683 (df = 469)	246.918 (df = 468)
F Statistic	3.811** (df = 2; 471)	2.753** (df = 3; 470)	2.547* (df = 3; 470)	2.070* (df = 4; 469)	2.865** (df = 3; 470)	2.289* (df = 4; 469)	1.849 (df = 5; 468)
Note:							*p<0.1; **p<0.05; ***p<0.01

Figure 12 depicts the revised model being tested for Hypothesis 3.

Figure 12: Revised Hypothesis 3 Model

$$HHI_t = HHI_0 + \ Total\ Investments + \sum State\ Control\ Factors + C$$

This model tests the same variables as before but attempts to remove some of the fluctuations based on starting HHI and is instead attempting to predict the ending HHI. Starting HHI may affect how much HHI can change within the period. A more concentrated market may be capable of larger shifts in HHI because a single merger or acquisition would sweep a larger share of the industry's existing firms. Figure 13 on the next page depicts the results from testing this model.

Figure 13: Hypothesis 3 Revised Model Results

	Dependent variable:						
	Year 3 HHI						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Starting HHI	0.984***	0.984***	0.984***	0.984***	0.984***	0.984***	0.985***
	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Total Investments	0.022**	0.022**	0.022**	0.022**	0.022**	0.022**	0.022**
	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)
Average Stake	68.934*	67.816*	69.936*	68.828*	71.748*	70.620*	72.698*
	(37.291)	(37.795)	(37.364)	(37.869)	(38.737)	(39.282)	(39.468)
SASAC Supervision		-5.608		-5.549		-5.338	-5.181
		(29.666)		(29.688)		(29.712)	(29.734)
BRI Contract			18.720	18.696			20.584
			(34.540)	(34.575)			(35.020)
Greenfield Investment					-7.756	-7.581	-10.188
					(28.548)	(28.594)	(28.955)
Constant	-28.481	-26.743	-32.565	-30.841	-27.991	-26.348	-30.723
	(30.918)	(32.285)	(31.845)	(33.186)	(31.000)	(32.351)	(33.218)
Observations	480	480	480	480	480	480	480
R^2	0.939	0.939	0.940	0.940	0.939	0.939	0.940
Adjusted R^2	0.939	0.939	0.939	0.939	0.939	0.939	0.939
Residual Std. Error	279.423 (df = 476)	279.707 (df = 475)	279.631 (df = 475)	279.916 (df = 474)	279.696 (df = 475)	279.981 (df = 474)	280.175 (df = 473)
F Statistic	2,463.063*** (df = 3; 476)	1,843.564*** (df = 4; 475)	1,844.630*** (df = 4; 475)	1,472.713*** (df = 5; 474)	1,843.722*** (df = 4; 475)	1,471.979*** (df = 5; 474)	1,225.013*** (df = 6; 473)
Note:							*p<0.1; **p<0.05; ***p<0.01

The revised model produced substantially higher R^2 and adjusted R^2 values without reaching the point of overspecification (Figure 13). The overall R^2 values in these models increased substantially after considering starting HHI. Starting HHI, total investment volume, and average stake were significant predictors at the .1 confidence level. However, the state control factors besides average stake remained non-significant. These results mirror the Hypothesis 2 findings that state control factors besides average stake are not significant predictors of HHI changes (Figure 13). None of the cases with the additional features showed improvement for both R^2 and adjusted R^2 values, indicating that changes in R^2 were offset by adjusted R^2 penalties for incorporating additional variables. Of the tested models, this one proved the most effective but parsimonious at predicting HHI changes (Figure 13).

Discussion

Congruence with Prior Literature

The findings from this project are consistent with journalistic descriptions of the investment strategies deployed by Chinese SOEs. Chinese companies in general historically tend to prefer inorganic growth through the acquisition of strategic assets, both physical and intangible (Deng, 2009). SOEs adopted this disposition, resulting in high profile deals that raised the suspicion of antitrust governance bodies. For instance, Zoomlion, the six largest construction machinery company in the world and the largest in China, acquired Compagnia Italiana Forme Acciaio (CIFA) and Powermole in 2008 and 2000, outbidding other interested companies (High, 2008). These companies were Zoomlion's rivals in Italy and the United Kingdom, respectively, and each was a dominant player on the global scale (High, 2008). Instead of attempting to outcompete them, Zoomlion relied on highly leveraged transactions to eliminate its challengers

and continues to pursue that approach today (O'Connor, 2018). In 2016, the company submitted a bid to purchase its US-based rival, Terex, despite already having debt over 43 times its earnings for the year (O'Connor, 2018). The bid was ultimately unsuccessful, but the sheer volume of transactions should continue to give pause to regulatory officials considering future SOE deals.

The negative coefficients for SASAC supervision could be explained by the additional levels of supervision from provincial and local governments that some SOEs must abide under (Heng, 2014). Provincial and local governments are significantly less concerned with international geopolitics and significantly more concerned with SOEs ability to provide local services (Heng, 2014). Furthermore, the extensive reporting guidelines and additional layers of middle management for SASAC SOEs may reduce their operational efficiency (Lu and Zhu, 2020). These superfluous instances of bureaucracy, among others, could result in SASAC SOEs being less agile in executing the investment strategies of other SOEs (Milhaupt and Pargendler, 2017).

Limitations of Findings

Like all indicators, the HHI is not always a perfect reflection of what it was designed to measure. The "relevant market fallacy" can occur when evaluating any transaction (Young, 2009). HHI computations can be based upon both infinitely specified industries to meaninglessly broad ones and still be valid mathematically (Young, 2009). For instance, a soft drink company could be considered in its specific flavored beverage industry within its town and nutritional classification, i.e. zero-sugar orange sodas in Round Rock, Texas. On the other side of the spectrum, the company could be considered within the industry of all liquids. Both conceptions are nonsensical and render the indicator useless. If the company were considering a merger, the

first classification would yield an astronomically large post-transaction HHI, even if both the buyer and target were small companies. The latter grouping would produce a very modest HHI figure, even if the two companies were multinational corporations. No specific guidelines exist for drawing industry boundaries for HHI calculations, so good-faith mistakes can also occur. Because of the leeway here, HHI will also vary naturally depending on the person examining it. Considering multiple sources and using a tiebreaker, if necessary, may be an effective way to reduce the impact of individual biases.

Additionally, critics argue that the HHI does not sufficiently weight consumer utility, for instance, when handling exceptions where one large company is better able to provide services for their needs (Roberts, 2014). If a credit card company can only reach nationwide acceptance by merchants after a series of mergers, consumers would clearly prefer that to having multiple credit cards even if it entailed higher fees (Roberts, 2014). In a situation where one company services half of all merchants and another services the other half, their merger may significantly enhance the proforma company's market power. The United States Federal Trade Commission would likely cancel this deal even though would it provide an enhanced service and contribute to consumer welfare. Toby Roberts, a staff attorney at the California Court of Appeals, proposes incorporating network effects and other drivers of customer satisfaction into a more holistic M&A evaluation framework.

Robustness Tests for Competition

For additional robustness checks on these findings, results could be measured in terms of changes in average price-cost margins (PCMs) and augmented relative profit differences (ARPDs) across industries. All are alternative measures of market competitiveness with

significant economic and mathematic backings. Each one captures aspects of competition absent from the HHI formula but, on their own, are not rigorous enough justify complete conclusions. With the HHI, they can paint a more comprehensive picture of an industry's competitive landscape.

The PCM represents the difference between the price and marginal cost of an item, and it can be calculated by reviewing line items on balance sheets and income statements (Amador et al., 2015). In congruence with the theory of perfectly competitive markets, lower PCM and lower overall profitability is characteristic of more competitive markets. An upward trend in the average PCM reflects an increase in market power wielded by the average player in an industry (Amador et al., 2015). A declining average PCM reflects a market becoming more competitive (Amador et al., 2015). In addition to describing shifts in market competition, research has shown that changes in average PCMs can also predict sensitivity to market shocks and financial crises (Görg and Warzynski, 2006; Amador et al., 2015). However, the PCM has not been proven theoretically robust. Contrary to predictions, in certain cases,[16] increasing competition can result in an industry's PCM increasing (Amir, 2003).

The ARPD is a modified version of the Boone Indicator or relative profit difference (RPD), which was proven to be more robust measure for market competition than the PCM (Schiersch and Schmidt-Ehmcke, 2010; Ansari, 2012; Boone, 2008). The RPD formula is as follows (Boone, 2008):

[16] The case described in this study was a simulated Cournot industry with increasing entrants that had different cost structures. A Cournot industry is a duopolistic one where firms produce homogenous products and choose quantity to produce simultaneously (see Cournot, A. A. & Fisher, Irving. (1929). Researches Into the Mathematical Principles of the Theory of Wealth. New York: Macmillan Company).

Figure 14: RPD Formula[17]

$$\text{RPD} = \frac{\pi(\text{typical firm}) - \pi(\text{least efficient firm})}{\pi(\text{most efficient firm}) - \pi(\text{least efficient firm})}$$

Under this logic, the higher the RPD, the more competitive a market; in a perfectly competitive market there are minimal differences between the profit of the most efficient and least efficient firms. Boone analyzed the banking industry and rationalized that competition boosts the profits of more efficient banks while destroying those of less efficient ones, thus causing them to exit (Boone, 2008).

However, the RPD does not account for firm size and thus the volume of innovation, which can lead to a misleadingly small RPD in broad sectors like manufacturing (Leuvensteijn et al., 2007; Schiersch and Schmidt-Ehmcke, 2010). The ARPD resolves that problem by dividing the profit terms in the original RPD equation by the gross revenue for a given period (Schiersch and Schmidt-Ehmcke, 2010):

Figure 15: ARPD Formula[18]

$$\text{ARPD} = \frac{\frac{\pi(\text{typical firm})}{\rho(\text{typical firm})} - \frac{\pi(\text{least efficient firm})}{\rho(\text{least efficient firm})}}{\frac{\pi(\text{most efficient firm})}{\rho(\text{most efficient firm})} - \frac{\pi(\text{least efficient firm})}{\rho(\text{least efficient firm})}}$$

Although the ARPD has been proven theoretically robust, there have been minimal explorations or tests of it outside of Schiersch and Schmidt-Ehmcke's work (Ansari, 2012). Until further applications of this indicator are explored, it should not be used authoritatively but rather in comparison or conjunction with other indicators.

[17] Let the notation $\pi(x)$ represent the profit of x where x is assumed to be a firm.
[18] Let the notation $\rho(x)$ represent the gross revenue of x where x is assumed to be a firm.

Should the results from either additional test not reinforce the HHI findings, a reevaluation of the conclusions from this project may the necessary. The mismatch between HHI, PCM, and ARPD could stem from differences in the measures themselves. Although the factors are attempting to reflect the same concept, their calculations are vastly different. One factor might be including metrics not relevant to the others or vice versa. Nonetheless, a mismatch could also indicate reasonable conflicting conclusions about the overall effect on market concentration. In such cases, the data and analyses would need to be reexamined to pinpoint the drivers of the inconsistencies between the statistics. Afterward, it would be worthwhile to discuss what these drivers reveal about different dimensions of market competition.

Robustness Tests for State Control

Different variables measuring the depth of CCP state influence could also be explored to test the validity of this paper's results. Additional factors could include the use of government resources, historical minimum Chinese government ownership stake, and the proportion of debt owed to Chinese government-affiliated entities versus wholly private ones. These variables, although not publicly available and difficult to compile, would explore different dimensions of influence that the CCP has on companies. A company that relies on conditional subsidies and uses SASAC directors as management consultants is retrained in its ability to pursue interests independent of the CCP. A company where the Chinese government has always held a majority stake has always had operations framed around state interests. Conversely, companies where that condition does not hold have had operations pursuing independent financial goals. A company that holds looming debt obligations to the Chinese government has a greater interest in

maximizing its cash flows to pay it off. It also has incentives to cater to CCP directors in hopes of receiving favorable refinancing rates or debt forgiveness. These companies may act in meaningfully different ways from those that do not rely on governmental support, did not originate with a large government ownership stake, and do not hold outstanding debts to the Chinese government adjacent lenders. Two of the three state control factors proved insignificant in this paper, but that result does not preclude the possibility of other ones being more useful for similar analyses.

Continuations

Continuations of this line of research could include investigating other financial metrics that reflect the health of an industry. Possible dependent variables could include average leverage ratios, capital intensity, multiples in M&A transactions, and the average return on assets. These metrics reflect themes in general equilibrium theory, like the ease of entry and exit into a market. If an industry's average leverage ratio is trending upwards, it likely is becoming more difficult to enter, as newcomers would likely need to assume more debt to survive. Conversely, if an industry's capital intensity is trending upwards, it likely is becoming more difficult to exit, as fixed assets tend to be attached to longer-term contracts.

Additionally, specific transactions completed by Chinese SOEs could be evaluated to see if they were worthwhile. SOEs' access to higher amounts of capital and capacity to hold debt allow them to pay otherwise absurd prices for acquisitions. Many bids and deals closed are arguably attempts for China to strengthen its claim to strategic resources or territories, like the South China Sea. The value of these potential geopolitical gains could be calculated with

consideration of contingent scenarios and compared to the expenses incurred with associated transactions.

Potential Applications of Findings

This paper's findings and analogous ones could be used for recommendations to investment promotion agencies against supporting Chinese SOE transactions. However, they could also be used for regulatory bodies, like the Federal Trade Commission, to create environments that minimize the harms of SOE investments and allow for recipient countries to enjoy the economic growth associated with them. Dobson, who encourages China SOE investments into Canada, reasons that any negative effects of these transactions could be resolved with increased regulatory oversight and devising consequences for noncompliance. Instead of outright restricting SOEs, their activities could be monitored from various standpoints including transparency and security (Dobson, 2014). Decisions to halt mergers could also not be bound to company size thresholds or other related metrics, so specific cautionary measures can be applied to SOEs (Young, 2009; Cheng et al., 2019).

One example of a targeted rule is the antitrust-related standard for Chinese SOEs that was devised by the European Commission[19] in 2016. Upon announcement of the potential joint venture between China General Nuclear Power (CGN) and Électricité de France (EDF), the Commission deemed it necessary to examine Chinese energy sector SOEs as a collective (Price, 2016). Instead of considering SOE transactions on the basis of individual companies, they can consider all SOEs in the same country and industry together. The sentiments of this move underly the results of this project. Because Chinese SOEs in the same sector jointly promote the

[19] The European Commission is the governing body that oversees antitrust issues within the EU.

same interests and benefit many of the same actors, they ought to be treated as one entity when considering antitrust issues. The shifts in market concentration are not dependent on the size or capabilities of each company individually but rather the combined presence of all Chinese SOEs in a given industry. At the very least, this regulatory change presents another obstacle for SOEs considering M&A transactions. Viewing Chinese SOEs as a class rather than individuals disarms the previously effective strategy of spreading investments across multiple CCP-controlled corporations. Although the CGN-EDF deal was eventually approved, Dr. Alan Riley of the Institute for Statecraft and Nicholas French, head of the China antitrust practice at Freshfields Bruckhaus Deringer, predict that this framework shift foreshadows tightening rules to come (Price, 2016).

Conclusion

Chinese SOEs rely on foreign operations and investments to secure income and promote Beijing's policy goals. Encoded in their functioning is allegiance to the CCP, and as such, the companies act collectively to maximize its profits and international influence. Over six decades, the companies shifted their focus from domestic services to foreign opportunities under market reforms implemented by different administrations. The current SOE expansion strategy uniquely utilizes M&A transactions instead of organic growth to expedite their rise to dominance and preemptively remove rivals within an industry. As China embarks on the BRI, with SOEs primarily leading the way, the historical economic effects of SOE investments should not be overlooked.

This project quantitatively tested one aspect of the notion that Chinese SOEs and the government entities behind them cause problematic results when they expand internationally.

The results of this paper support initiatives to further regulate the M&A activity of Chinese SOEs and limit their presence in the global economy. It found that foreign investments of Chinese SOEs tend to significantly increase market concentration in recipient industries based on the size of their commitments and the strength of CCP influence on a company. Both numerical figures and descriptive accounts illustrate how the investment strategies of Chinese SOEs can create less competitive markets. The structure of markets reflects dynamics between consumers, corporations, and governments, and it is crucial to protect for the promotion of societal wellbeing and innovative progress.

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[20] This project analyzes 2001-2012 European Union firm-level differences in PCM between like industries. It concludes that firm-level data can be effectively translated into country-level data and that changes in PCM correlate with how severely a firm was impacted by previous financial crises.

[21] CORE is the "world's largest collection of open access research papers" (see CORE (n.d.), core.ac.uk). This paper was featured in the 2003 Discussion Papers Series they hosted.

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[23] The authors describe common structures for separating cash flow rights, i.e. for dividends because of equity ownership, and control rights, i.e. voting rights. They focus on situations where the majority of control shareholders do not possess a majority of the cash flow rights in a company. The paper highlights the consequences and agency costs that arise from this potential misalignment of priorities between shareholders, showing cases where there are significant disadvantages to the aforementioned situations. They argue that these agency costs are also likely to be higher than those of capital structures with high amounts of debt.

[24] This paper founded the Boone Indicator or RPD.

[25] This article describes how the Chinese Communist Party currently aims to secure control over private businesses by offering supporting resources not available otherwise. Xi argues that success in this goal will also lead to "healthy development of the private economy". For decades, the government has attempted a balancing act between ensuring loyalty from private companies and "allowing sufficient autonomy to develop a competitive economy". Amid COVID-19 the administration released a new economic growth strategy that involves Party officials establishing more lines of communication for more frequent contact with business owners.

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[26] This book provides a comprehensive look into how the BRI falls into China's larger globalization plans and political motives using four sections: 1) "Comprehension and Communication on the 'Belt and Road' Initiative", 2) "Regional Cooperation in the 'Belt and Road' Initiative", 3) "Economic Cooperation in the 'Belt and Road' Initiative", and 4) "Geopolitical Challenge in the 'Belt and Road' Initiative". Each section comprises articles and case studies written by post-doctoral researchers, lecturers, professors, and graduate students at various universities. This book is a fantastic starting point for research on the BRI, because it covers practically every topic of significance, including global public opinion, international stakeholders, diplomacy, and more. Not all the book is publicly available online, but one of the uncovered sections discussed how China attempts to manipulate media in nearby areas to promote positive coverage of the BRI. Control of the internet infrastructure could thus be a lever China uses to continuously further those projects and their long-term goals with media.

[27] This book founded crucial economic concepts including Cournot competition and Nash equilibrium.

[28] This paper attempts to answer why Chinese firms, especially those in the technology industry, tend to use inorganic growth—through mergers and acquisitions (M&A)—instead of organic growth—through research and development or marketing—when expanding globally. The author, Ping Deng is a Professor of Business Administration at the John E. Simon School of Business at Maryville University of St. Louis. Deng uses case studies of TCL, BOE, and Lenovo to argue that companies are resource-driven and that Chinese companies in particular are in a unique institutional environment that facilitates M&A activity. In considering different scenarios and trajectories that companies may take, Deng uses analytical models to support his reasoning.

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Appendices

Appendix 1: Glossary of Acronyms

a. ARPD – Augmented relative profit difference. The ARPD is a weighted measure of market competition that adjusts the RPD of an industry based on the gross revenue of relevant firms (Schiersch and Schmidt-Ehmcke, 2010). See Appendix 1g for explanation of the RPD. Refer to Figure 15 and its associated paragraphs for more details and calculations about the ARPD.
b. BRI – Belt and Road Initiative. The Belt and Road Initiative is a multi-trillion-dollar global infrastructure project that the Chinese government announced in 2013.
c. CCP – Chinese Communist Party. The Chinese Communist Party is the governing political party in China and faces no significant institutional opposition.
d. HHI – Herfindahl-Hirschman Index. Refer to Figure 3 and its associated paragraphs for more details and calculations about the HHI.
e. M&A – Mergers and acquisitions. Mergers occur when two companies decide to combine into one. Acquisitions occur when one company wants to purchase another company either to subsume it or to establish it as a subsidiary.
f. NAICS – North American Industry Classification System. NAICS is the industry classification system used by the United States, Canada, and Mexico (Office of Management and Budget, 2017). It groups like businesses together based on their production processes and assigns codes to each group with increasing specificity as more digits are added (Office of Management and Budget, 2017).
g. OBOR – One Belt One Road. See Appendix 1b; OBOR is an alternative abbreviation for the BRI.

h. PCM – Price-cost margin. The PCM is the difference between the price and marginal cost of a good or service (Amador et al., 2015). Changes in the average PCM of an industry are used to describe changes in its competitive landscape. A lower PCM represents higher competition while a higher PCM represents the opposite.
i. RPD – Relative profit difference. The RPD is a measure of how competitive a market is based on the profits of the least, average, and most efficient companies within an industry (Boone, 2008). Refer to Figure 14 and its associated paragraph for more details and calculations.
j. SASAC – State-Owned Assets Supervision and Administration Commission. The State-Owned Assets Supervision and Administration Commission is an agency within China's State Council that oversees the operations of 97 most central SOEs.
k. SOE – State-owned enterprise. State-owned enterprises are companies that are partially or wholly operated or owned by a national, provincial, or local government.

Appendix 2: Glossary of Terms

a. Brownfield – For brownfield investments, a company purchases access to existing facilities in a foreign country to launch its expansion into it.
b. Greenfield – For greenfield investments, a company builds its facilities from the ground up without using on preexisting fixed assets of other companies.
c. Market competitiveness – Market competitiveness in general equilibrium theory refers to the quality of a market to 1) naturally produce one prevailing price that constrains all sellers of a product and 2) satisfy all buyer demand at that prevailing price. Market

concentration is associated with market competitiveness, because it relates to the amount of companies competing in an industry.

Appendix 3: Complete Explanation of Source Data

The file titled "intsheets" was created to centralize all the sheets the final dataset would reference.[35] The following sheets in order were added to this file in individual tabs:

- naics: Contains four-digit, three-digit, and two-digit NAICS codes for relevant industries (Office of Management and Budget, 2017). The four-digit codes were manually entered, but the three-digit and two-digit ones were calculated using the formulas LEFT(B2, 3) and LEFT(C2, 3), respectively.
- cmpnycode: Contains an ascending numeric code for relevant companies. Companies were copied from the invdata sheet, duplicates were removed, and the remaining cells were sorted alphabetically and given incrementing codes beginning with 1. This sheet also contains data for the government ownership stake at the time of investment and the presence of SASAC supervision. This data accumulated from multiple sources with the latter two columns being filled in manually.
- sasac: Contains a list of central SOEs that are supervised by SASAC, including both the Chinese names and the English translation (State-owned Assets Supervision and Administration Commission of the State Council, n.d.).
- invdata: Contains a copy of the China Global Investment Tracker (Scissors, 2020). The columns with multiple stakes or companies were divided into multiple

[35] The title was intended to be a shorthand for "Intermediate Sheets."

rows, and their collective investment was assumed to be split equally unless available information stated otherwise. Additionally, the blank subsector sells were populated with the sector in the column directly to the left. Lastly, one edit was made to further specify the industries being invested in. In 2014, one investment into Canada was categorized as "Other" in its industry subsector. For accuracy, the industry was changed to "Advertising" because the investing company was BlueFocus Communication Group, one of the top public relations companies in Asia (Forbes, n.d.).

- hhi-tc: Contains a copy of the HH Market Concentration Index created by TCdata360 (The World Bank, n.d.).[36]
- hhi-wits: Contains a copy of the HHI data compiled for the WITS database (The World Bank, n.d.).
- ctrycode: Contains an ascending numeric code for relevant countries. Countries were copied from the invdata sheet, duplicates were removed, and the remaining cells were sorted alphabetically and given incrementing codes beginning with 1.

Appendix 4: Complete Explanation of Data Cleaning and Analysis

Coding for R with comments can be found in the attached files. Formulas in each csv file were removed and replaced with the text of their values to reduce file sizes. The instructions below describe how to recreate the final csv file used for analysis.

[36] This HHI data was eventually replaced with the data from WITS. As such, it is not necessary to include in the intsheets file if desired.

To replicate the "thesisdata" csv file, first, filter out the blank cells in Column E ("Share Size"), and copy the country, subsector,[37] and year columns from the invdata tabs in intsheets. Delete values where the year is greater than 2015. Use the following formulas to then add the four-digit, three-digit, and two-digit NAICS codes, respectively, for the industries:

- naics4: INDEX ([intsheets.xlsx] NAICS! $B$2 : $B$36, MATCH (B2, [intsheets.xlsx] NAICS! $A$2: $A$36, 0))[38]
- naics3: INDEX ([intsheets.xlsx] NAICS! $C$2 : $C$36, MATCH (B2, [intsheets.xlsx] NAICS! $A$2: $A$36, 0))
- naics2: INDEX ([intsheets.xlsx] NAICS! $D$2 : $D$36, MATCH (B2, [intsheets.xlsx] NAICS! $A$2: $A$36, 0))

Highlight the country, industry, and four-digit NAICS code columns, and use the remove duplicates Excel function to keep only the unique combinations. At this point, there should 515 rows, including the title row, remaining.

The following table describes the thesisdata column names and the remaining steps for replicating it using intsheets and Excel formulas. Columns are listed in the left-to-right order they appear in the final sheet.

Figure 16: Replication Table for thesisdata.csv

[37] This value was used instead of sector to describe an industry because it allowed for a higher level of disaggregation that could be reversed if needed.
[38] Remove the spaces when entering this text into Excel. Spaces were added to improve the readability of long formulas.

Column Name (Letter)	Data Stored	Excel Formula
id	The unique value that represents the row being used. It is created from the concatenation of a four-digit industry code, country code, and year.[39]	CONCATENATE(C2,"_",F2,"_",E2)[40]
ctrycode	The corresponding country code from the ctrycode page in the intsheets file.	INDEX (' [intsheets.xlsx] ctrycode'! $B$2: $B$125, MATCH(B2,'[intsheets.xlsx]ctrycode'!$A$2:$A$125,0))[41]
naics4	Explained above.	Explained above.
naics3	Explained above.	Explained above.
naics2	Explained above.	Explained above.

[39] This process can be replaced with concatenating the industry name, country, and year. Codes were used to minimize the influence of preconceptions when initially interpreting the data.
[40] For this formula, "ctrycode" was in Column C, "naics4" was in Column F, and "year" was in column E of thesisdata.
[41] For this formula, Column B of thesisdata had the list of countries created at the beginning.

Column Name (Letter)	Data Stored	Excel Formula
num_cmpny	The number of companies that invested in a given country, industry, and year	COUNTIFS('[intsheets.xlsx] invdata'! $A$5: $A$1701, "="&E2, '[intsheets.xlsx] invdata'!$I$5:$I$1701,"="&B2,'[intsheets.xlsx]invdata'! $H$5: $H$1701, "="&D2, '[intsheets.xlsx] invdata'! $E$5: $E$1701, ">"&0)

Column Name (Letter)	Data Stored	Excel Formula
cmpny1	The company code of the first company listed in the invdata table that invested in the corresponding country and industry during the corresponding year.	The “id” column is first added as the first column in the invdata sheet in intsheets using the following formula: IF(AND(NOT(F5=0),B5< 2016), CONCATENATE (VLOOKUP(J5,ctrycode! $A$2:$B$125,2,FALSE),"_", VLOOKUP(I5,naics!$A$2: $B$36,2,FALSE),"_",B5),""). Then in the thesisdata file, cmpny1 is found using this formula: INDEX([intsheets. xlsx]cmpnycode!$A$2: $A$661,MATCH(VLOOKUP(A2,[intsheets. xlsx]invdata!$A$5:$D$1701, 4,FALSE),[intsheets.xlsx] cmpnycode!$B$2:$B$661,0))

Column Name (Letter)	Data Stored	Excel Formula
cmpny1_inv	The amount in millions of dollars that Company 1 invested in this country, industry, and year.	VLOOKUP(A2,[intsheets.xlsx]invdata!$A$5:$E$1701,5,FALSE)
cmpny1_stake	The Chinese government's current percent equity stake in Company 1.	VLOOKUP(A2,[intsheets.xlsx]invdata!$A$5:$F$1760,6,FALSE)
cmpny1_sasac	Whether Company 1 is supervised by SASAC. The value is "1" if they are and "0" if they are not.	VLOOKUP(J2,[intsheets.xlsx]cmpnycode!$A$2:$E$661,5,FALSE)
cmpny1_bri	Whether this investment by Company 1 was involved with the BRI. The value is "1" if it was and "0" if it was not.	IF(VLOOKUP(A2,[intsheets.xlsx]invdata!$A$5:$L$1760,12,FALSE)="",0,VLOOKUP(A2,[intsheets.xlsx]invdata!$A$5:$L$1760,12,FALSE))
cmpny1_grnfld	Whether the Company 1 investment was a greenfield investment. The value is "1" if it was and "0" if it was not.	IF(VLOOKUP(A2,[intsheets.xlsx]invdata!$A$5:$M$1760,13,FALSE)="G",1,0)

Column Name (Letter)	Data Stored	Excel Formula
cmpny2	The second company listed in the invdata table that invested in the corresponding country and industry during the corresponding year. Cells are blank if there is no second company.	Filter out rows where num_cmpny equals 1. Use the following formula beginning with the first entry, which should be on the third row: INDEX([intsheets.xlsx] cmpnycode!$A$2:$A$661, MATCH(INDEX([intsheets. xlsx] invdata!$D$5:$D$1760, SMALL(IF([intsheets.xlsx] invdata!$A$5:$A$1760=A3, ROW([intsheets.xlsx]invdata! $A$5:$A$1760)-MIN(ROW([intsheets.xlsx]invdata!$A$5: $A$1760))+1),2)),[intsheets. xlsx]cmpnycode!$B$2: $B$661,0),)

Column Name (Letter)	Data Stored	Excel Formula
cmpny2_inv	The amount in millions of dollars that Company 2 invested in this country, industry, and year. Cells are blank if there is no second company.	{INDEX([intsheets. xlsx]invdata!$E$5:$E$1760, MATCH(1,(A3=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(P3,[intsheets. xlsx]cmpnycode!$A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}[42]
cmpny2_stake	The Chinese government's current percent equity stake in Company 2. Cells are blank if there is no second company.	{INDEX([intsheets.xlsx] invdata!$F$5:$F$1760, MATCH(1,(A3=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(P3,[intsheets. xlsx]cmpnycode!$A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}

[42] The brackets indicate an array formula. Array formulas must be applied using Ctrl+Shift+Enter. The "+" used in commands here indicates a need to hold down the two keys simultaneously. Meanwhile, the "-", if used, indicates that the buttons should be pressed in succession, not at the same time.

Column Name (Letter)	Data Stored	Excel Formula
cmpny2_sasac	Whether Company 2 is supervised by SASAC. The value is “1” if they are and “0” if they are not.	VLOOKUP(P3,[intsheets.xlsx]cmpnycode!$A$2:$E$661,5,FALSE)
cmpny2_bri	Whether this investment by Company 2 was involved with the BRI. The value is “1” if it was and “0” if it was not. Cells are blank if there is no second company.	{INDEX([intsheets.xlsx]invdata!$L$5:$L$1760, MATCH(1,(A3=[intsheets.xlsx]invdata!$A$5:$A$1760)*(VLOOKUP(P3,[intsheets.xlsx]cmpnycode!$A$2:$B$661,2,FALSE)=[intsheets.xlsx]invdata!$D$5:$D$1760),0))}
cmpny2_grnfld	Whether the Company 2 investment was a greenfield investment. The value is “1” if it was and “0” if it was not. Cells are blank if there is no second company.	IF(INDEX([intsheets.xlsx]invdata!$M$5:$M$1760, MATCH(1,(A3=[intsheets.xlsx]invdata!$A$5:$A$1760)*(VLOOKUP(P3,[intsheets.xlsx]cmpnycode!$A$2:$B$661,2,FALSE)=[intsheets.xlsx]invdata!$D$5:$D$1760),0))="G",1,0)

Column Name (Letter)	Data Stored	Excel Formula
cmpny3	The third company listed in the invdata table that invested in the corresponding country and industry during the corresponding year. Cells are blank if there is no third company.	Filter out rows where num_cmpny equals 1 or 2. Use the following formula beginning with the first entry, which should be on the 28th row: INDEX([intsheets.xlsx]cmpnycode!$A$2:$A$661,MATCH(INDEX([intsheets.xlsx]invdata!$D$5:$D$1760,SMALL(IF([intsheets.xlsx]invdata!$A$5:$A$1760=A28,ROW([intsheets.xlsx]invdata!$A$5:$A$1760)-MIN(ROW([intsheets.xlsx]invdata!$A$5:$A$1760))+1),3)),[intsheets.xlsx]cmpnycode!$B$2:$B$661,0),)

Column Name (Letter)	Data Stored	Excel Formula
cmpny3_inv	The amount in millions of dollars that Company 3 invested in this country, industry, and year. Cells are blank if there is no third company.	{INDEX([intsheets. xlsx]invdata!$E$5:$E$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(P28,[intsheets. xlsx]cmpnycode!$A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny3_stake	The Chinese government's current percent equity stake in Company 3. Cells are blank if there is no third company.	{INDEX([intsheets.xlsx] invdata!$F$5:$F$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(V28,[intsheets. xlsx]cmpnycode!$A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))
cmpny3_sasac	Whether Company 3 is supervised by SASAC. The value is "1" if they are and "0" if they are not.	VLOOKUP(V28,[intsheets. xlsx]cmpnycode!$A$2: $E$661,5,FALSE)

Column Name (Letter)	Data Stored	Excel Formula
cmpny3_bri	Whether this investment by Company 3 was involved with the BRI. The value is "1" if it was and "0" if it was not. Cells are blank if there is no third company.	{INDEX([intsheets.xlsx] invdata!$L$5:$L$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(V28,[intsheets. xlsx]cmpnycode!$A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny3_grnfld	Whether the Company 3 investment was a greenfield investment. The value is "1" if it was and "0" if it was not. Cells are blank if there is no third company.	IF(INDEX([intsheets.xlsx] invdata!$M$5:$M$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(V28,[intsheets. xlsx]cmpnycode!$A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))="G",1,0)

Column Name (Letter)	Data Stored	Excel Formula
cmpny4	The fourth company listed in the invdata table that invested in the corresponding country and industry during the corresponding year. Cells are blank if there is no fourth company.	Filter out rows where num_cmpny equals 1, 2, or 3. Use the following formula beginning with the first entry, which should be on the 28th row: INDEX([intsheets.xlsx]cmpnycode!$A$2:$A$661,MATCH(INDEX([intsheets.xlsx]invdata!$D$5:$D$1760,SMALL(IF([intsheets.xlsx]invdata!$A$5:$A$1760=A28,ROW([intsheets.xlsx]invdata!$A$5:$A$1760)-MIN(ROW([intsheets.xlsx]invdata!$A$5:$A$1760))+1),4)),[intsheets.xlsx]cmpnycode!$B$2:$B$661,0),)

Column Name (Letter)	Data Stored	Excel Formula
cmpny4_inv	The amount in millions of dollars that Company 4 invested in this country, industry, and year. Cells are blank if there is no fourth company.	{INDEX([intsheets. xlsx]invdata!$E$5:$E$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(A28, [intsheets.xlsx]cmpnycode! $A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny4_stake	The Chinese government's current percent equity stake in Company 4. Cells are blank if there is no fourth company.	{ INDEX([intsheets.xlsx] invdata!$F$5:$F$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AB28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny4_sasac	Whether Company 4 is supervised by SASAC. The value is "1" if they are and "0" if they are not.	=VLOOKUP(AB28, [intsheets.xlsx]cmpnycode! $A$2:$E$661,5,FALSE)

Column Name (Letter)	Data Stored	Excel Formula
cmpny4_bri	Whether this investment by Company 4 was involved with the BRI. The value is "1" if it was and "0" if it was not. Cells are blank if there is no fourth company.	{INDEX([intsheets.xlsx] invdata!$L$5:$L$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AB28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))
cmpny4_grnfld	Whether the Company 4 investment was a greenfield investment. The value is "1" if it was and "0" if it was not. Cells are blank if there is no fourth company.	IF(INDEX([intsheets.xlsx] invdata!$M$5:$M$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AB28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))="G",1,0)

Column Name (Letter)	Data Stored	Excel Formula
cmpny5	The fifth company listed in the invdata table that invested in the corresponding country and industry during the corresponding year. Cells are blank if there is no fifth company.	Filter out rows where num_cmpny equals 1, 2, 3, or 4. Use the following formula beginning with the first entry, which should be on the 28th row: INDEX([intsheets.xlsx]cmpnycode!$A$2:$A$661,MATCH(INDEX([intsheets.xlsx]invdata!$D$5:$D$1760,SMALL(IF([intsheets.xlsx]invdata!$A$5:$A$1760=A28,ROW([intsheets.xlsx]invdata!$A$5:$A$1760)-MIN(ROW([intsheets.xlsx]invdata!$A$5:$A$1760))+1),5)),[intsheets.xlsx]cmpnycode!$B$2:$B$661,0),)

Column Name (Letter)	Data Stored	Excel Formula
cmpny5_inv	The amount in millions of dollars that Company 5 invested in this country, industry, and year. Cells are blank if there is no fifth company.	{INDEX([intsheets. xlsx]invdata!$E$5:$E$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AH28, [intsheets.xlsx]cmpnycode! $A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny5_stake	The Chinese government's current percent equity stake in Company 5. Cells are blank if there is no fifth company.	{INDEX([intsheets.xlsx] invdata!$F$5:$F$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AH28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny5_sasac	Whether Company 5 is supervised by SASAC. The value is "1" if they are and "0" if they are not.	VLOOKUP(AH28,[intsheets. xlsx]cmpnycode!$A$2: $E$661,5,FALSE)

Column Name (Letter)	Data Stored	Excel Formula
cmpny5_bri	Whether this investment by Company 5 was involved with the BRI. The value is "1" if it was and "0" if it was not. Cells are blank if there is no fifth company.	{INDEX([intsheets.xlsx] invdata!$L$5:$L$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AH28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny5_grnfld	Whether the Company 5 investment was a greenfield investment. The value is "1" if it was and "0" if it was not. Cells are blank if there is no fifth company.	IF(INDEX([intsheets.xlsx] invdata!$M$5:$M$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AH28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))="G",1,0)

Column Name (Letter)	Data Stored	Excel Formula
cmpny6	The sixth company listed in the invdata table that invested in the corresponding country and industry during the corresponding year. Cells are blank if there is no sixth company.	Filter out rows where num_cmpny equals 1, 2, 3, or 4.[43] Use the following formula beginning with the first entry, which should be on the 28th row: INDEX([intsheets. xlsx]cmpnycode!$A$2: $A$661,MATCH(INDEX([intsheets.xlsx]invdata!$D$5: $D$1760,SMALL(IF([intsheets.xlsx]invdata!$A$5: $A$1760=A28,ROW([intsheets.xlsx]invdata!$A$5: $A$1760)-MIN(ROW([intsheets.xlsx]invdata!$A$5: $A$1760))+1),6)),[intsheets. xlsx]cmpnycode!$B$2:$B$66 1,0),)

[43] No rows have exactly five companies.

Column Name (Letter)	Data Stored	Excel Formula
cmpny6_inv	The amount in millions of dollars that Company 6 invested in this country, industry, and year. Cells are blank if there is no sixth company.	{INDEX([intsheets. xlsx]invdata!$E$5:$E$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AN28, [intsheets.xlsx]cmpnycode! $A$2: $B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny6_stake	The Chinese government's current percent equity stake in Company 6. Cells are blank if there is no sixth company.	{ =INDEX([intsheets.xlsx] invdata!$F$5:$F$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AN28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny6_sasac	Whether Company 6 is supervised by SASAC. The value is "1" if they are and "0" if they are not.	VLOOKUP(AN28,[intsheets. xlsx]cmpnycode!$A$2: $E$661,5,FALSE)

Column Name (Letter)	Data Stored	Excel Formula
cmpny6_bri	Whether this investment by Company 6 was involved with the BRI. The value is "1" if it was and "0" if it was not. Cells are blank if there is no sixth company.	{INDEX([intsheets.xlsx] invdata!$L$5:$L$1760, MATCH(1,(A28=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AN28, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))}
cmpny6_grnfld	Whether the Company 6 investment was a greenfield investment. The value is "1" if it was and "0" if it was not. Cells are blank if there is no sixth company.	IF(INDEX([intsheets.xlsx] invdata!$M$5:$M$1760, MATCH(1,(A230=[intsheets. xlsx]invdata!$A$5:$A$1760) *(VLOOKUP(AN230, [intsheets.xlsx]cmpnycode! $A$2:$B$661,2,FALSE)= [intsheets.xlsx]invdata!$D$5: $D$1760),0))="G",1,0)
total_inv	The total amount of investments in millions that were received in an industry over one year.	SUM(N2,T2,Z2,AF2,AL2, AQ2)

Column Name (Letter)	Data Stored	Excel Formula
avgstake	Simple average of the government ownership stakes in the investing companies for the evaluation period	AVERAGE(O2,U2,AA2, AG2,AM2,AS2)
w_avgstake	Weighted average of the government ownership stakes based on the investment sizes of companies for the evaluation period	SUM(N2*O2/AW2,T2*U2/ AW2,Z2*AA2/AW2,AF2* AG2/AW2,AL2*AM2/AW2, AR2*AS2/AW2)
hhi_0	HHI in the year of investment	10000*VLOOKUP(B2,[intsh eets.xlsx]hhi!$A$2:$Q$207, E2-[intsheets.xlsx]hhi!$D$1 +3,FALSE)
hhi_1	HHI one year after investment	10000*VLOOKUP(B2,[intsh eets.xlsx]hhi!$A$2:$Q$207, E2- [intsheets.xlsx]hhi!$D$1 +4,FALSE)
1yr_hhichange	HHI change over one year	BD2-BC2
1yr_hhichange_bin	Whether HHI increased in one year. The value is “1” if it did and “0” if it did not.	IF(AND(BE2<>””,BE2>0),1, IF(AND(BE2<>””,BE2<0,0,” ”))

Column Name (Letter)	Data Stored	Excel Formula
hhi_2	HHI two years after investment	10000*VLOOKUP(B2,[intsheets.xlsx]hhi!$A$2:$Q$207, E2- [intsheets.xlsx]hhi!$D$1 +5,FALSE)
2yr_hhichange	HHI change over two years	BG2-BD2
2yr_hhichange_bin	Whether HHI increased in two years. The value is “1” if it did and “0” if it did not.	IF(AND(BH2<>””,BH2>0),1 ,IF(AND(BH2<>””,BH2<0,0, ””))
hhi_3	HHI three years after investment	10000*VLOOKUP(B2,[intsheets.xlsx]hhi!$A$2:$Q$207, E2- [intsheets.xlsx]hhi!$D$1 +6,FALSE)
3yr_hhichange	HHI change over three years	BJ2-BG2
3yr_hhichange_bin	Whether HHI increased in one year. The value is “1” if it did and “0” if it did not.	IF(AND(BK2<>””,BK2>0),1 ,IF(AND(BK2<>””,BK2<0,0, ””))

In the interest of reducing storage space and improving processing times, use the Ctrl+A command and then the Alt-H-V-V command to copy the entire sheet and only retain its values with no formulas. Out of convention, the industry and country columns first created were deleted and the “id” column was moved to Column A.

Appendix 5: Compilation of Figures

a. Figure 1: Hypothesis 1 Model

$$\Delta Competitveness = Total\ Investments + C$$

b. Figure 2: Hypothesis 2 Model

$$\Delta Competitiveness = \sum State\ Control\ Factors + C$$

c. Figure 3: Hypothesis 3 Model

$$\Delta Competitiveness = Total\ Investments + \sum State\ Control\ Factors + C$$

d. Figure 4: HHI Formula

$$HHI = \sum_{i=1}^{n} {s_i}^2$$

$$s_i = \frac{\rho(x_i)}{\sum_{i=1}^{n} x_i}$$

e. Figure 5: Hypothesis 1 Model Results

	Dependent variable:	
	HHI Increase Amount	Likelihood of HHI Increase
	OLS	*logistic*
	(1)	(2)
Total Investments	0.021**	0.0001
	(0.009)	(0.0001)
Constant	-1.640	0.257**
	(15.464)	(0.112)
Observations	480	484
R^2	0.011	
Adjusted R^2	0.009	
Log Likelihood		-329.477
Akaike Inf. Crit.		662.954
Residual Std. Error	280.356 (df = 478)	
F Statistic	5.259** (df = 1; 478)	
Note:		*p<0.1; **p<0.05; ***p<0.01

f. Figure 6: Yearly Average Total Investments by Time Period and HHI Change

	Average Total Investments
1 Year HHI Increase	1005.3760
1 Year HHI Decrease	901.2195
2 Year HHI Increase	956.9636
2 Year HHI Decrease	954.7210
3 Year HHI Increase	986.8898
3 Year HHI Decrease	917.4091

g. Figure 7: Hypothesis 2 Model Results

	Dependent variable:			
	HHI Change			
	(1)	(2)	(3)	(4)
Average Stake	63.015*	61.812*	63.326*	62.118*
	(32.964)	(33.478)	(33.039)	(33.551)
SASAC Supervision		-5.362		-5.397
		(25.187)		(25.213)
BRI Contract			5.882	5.930
			(31.031)	(31.064)
Constant	-15.880	-13.521	-17.017	-14.653
	(23.522)	(26.021)	(24.298)	(26.714)
Observations	474	474	474	474
R^2	0.008	0.008	0.008	0.008
Adjusted R^2	0.006	0.004	0.004	0.002
Residual Std. Error	247.331 (df = 472)	247.581 (df = 471)	247.584 (df = 471)	247.835 (df = 470)
F Statistic	3.654* (df = 1; 472)	1.846 (df = 2; 471)	1.841 (df = 2; 471)	1.240 (df = 3; 470)
Note:				*p<0.1; **p<0.05; ***p<0.01

h. Figure 8: Overall Change in HHI

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
1 Year HHI Change	484	17.085	253.099	-1,320.378	-16.891	34.296	3,515.398
2 Year HHI Change	480	18.270	281.600	-1,069.959	-29.995	49.197	3,998.256
3 Year HHI Change	474	23.493	248.024	-1,183.220	-33.674	71.740	2,013.027

i. Figure 9: Change in HHI for Majority Stake Transactions

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
1 Year HHI Change	290	26.534	306.414	-1,320.378	-20.496	34.772	3,515.398
2 Year HHI Change	287	27.447	330.892	-1,069.959	-29.995	66.133	3,998.256
3 Year HHI Change	281	38.809	271.035	-1,183.220	-31.094	83.211	2,013.027

j. Figure 10: Change in HHI for Minority Stake Transactions

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
1 Year HHI Change	194	2.960	139.241	-784.385	-16.156	33.786	1,038.859
2 Year HHI Change	193	4.623	185.544	-1,065.712	-29.481	32.784	1,118.444
3 Year HHI Change	193	1.194	208.745	-1,175.840	-43.739	39.381	477.038

k. Figure 11: Hypothesis 3 Model Results

	Dependent variable:						
	HHI Change						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Total Investments	0.016**	0.018**	0.016**	0.018**	0.016*	0.017**	0.017**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Average Stake	68.905**	64.890*	69.212**	65.199*	78.058**	73.930**	74.892**
	(32.995)	(33.385)	(33.070)	(33.457)	(34.275)	(34.724)	(34.881)
SASAC Supervision		-20.990		-21.026		-19.758	-19.761
		(26.143)		(26.170)		(26.178)	(26.203)
BRI Contract			5.816	5.995			10.228
			(30.935)	(30.947)			(31.247)
Greenfield Investment					-24.942	-23.994	-25.148
					(25.275)	(25.318)	(25.586)
Constant	-34.844	-27.854	-35.967	-28.999	-32.171	-25.693	-27.543
	(25.318)	(26.783)	(26.038)	(27.454)	(25.464)	(26.882)	(27.495)
Observations	474	474	474	474	474	474	474
R^2	0.016	0.017	0.016	0.017	0.018	0.019	0.019
Adjusted R^2	0.012	0.011	0.010	0.009	0.012	0.011	0.009
Residual Std. Error	246.563 (df = 471)	246.656 (df = 470)	246.816 (df = 470)	246.909 (df = 469)	246.570 (df = 470)	246.683 (df = 469)	246.918 (df = 468)
F Statistic	3.811** (df = 2; 471)	2.753** (df = 3; 470)	2.547* (df = 3; 470)	2.070* (df = 4; 469)	2.865** (df = 3; 470)	2.289* (df = 4; 469)	1.849 (df = 5; 468)

Note: *p<0.1; **p<0.05; ***p<0.01

l. Figure 12: Revised Hypothesis 3 Model

$$HHI_t = HHI_0 + \ Total\ Investments + \sum State\ Control\ Factors + C$$

m. Figure 13: Hypothesis 3 Models Continued

	Dependent variable:						
	Year 3 HHI						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Starting HHI	0.984***	0.984***	0.984***	0.984***	0.984***	0.984***	0.985***
	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Total Investments	0.022**	0.022**	0.022**	0.022**	0.022**	0.022**	0.022**
	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)
Average Stake	68.934*	67.816*	69.936*	68.828*	71.748*	70.620*	72.698*
	(37.291)	(37.795)	(37.364)	(37.869)	(38.737)	(39.282)	(39.468)
SASAC Supervision		-5.608		-5.549		-5.338	-5.181
		(29.666)		(29.688)		(29.712)	(29.734)
BRI Contract			18.720	18.696			20.584
			(34.540)	(34.575)			(35.020)
Greenfield Investment					-7.756	-7.581	-10.188
					(28.548)	(28.594)	(28.955)
Constant	-28.481	-26.743	-32.565	-30.841	-27.991	-26.348	-30.723
	(30.918)	(32.285)	(31.845)	(33.186)	(31.000)	(32.351)	(33.218)
Observations	480	480	480	480	480	480	480
R^2	0.939	0.939	0.940	0.940	0.939	0.939	0.940
Adjusted R^2	0.939	0.939	0.939	0.939	0.939	0.939	0.939
Residual Std. Error	279.423 (df = 476)	279.707 (df = 475)	279.631 (df = 475)	279.916 (df = 474)	279.696 (df = 475)	279.981 (df = 474)	280.175 (df = 473)
F Statistic	2,463.063*** (df = 3; 476)	1,843.564*** (df = 4; 475)	1,844.630*** (df = 4; 475)	1,472.713*** (df = 5; 474)	1,843.722*** (df = 4; 475)	1,471.979*** (df = 5; 474)	1,225.013*** (df = 6; 473)
Note:							*p<0.1; **p<0.05; ***p<0.01

n. Figure 14: RPD Formula

$$\text{RPD} = \frac{\pi(\text{typical firm}) - \pi(\text{least efficient firm})}{\pi(\text{most efficient firm}) - \pi(\text{least efficient firm})}$$

o. Figure 15: ARPD Formula

$$\text{RPD} = \frac{\frac{\pi(\text{typical firm})}{\rho(\text{typical firm})} - \frac{\pi(\text{least efficient firm})}{\rho(\text{least efficient firm})}}{\frac{\pi(\text{most efficient firm})}{\rho(\text{most efficient firm})} - \frac{\pi(\text{least efficient firm})}{\rho(\text{least efficient firm})}}$$

p. See Appendix 2 above for Figure X: Replication Table for thesisdata.csv.